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ANALYSIS OF KNOWN AND NEW HOST RECORDS FOR *TEPHRITIS* FROM CALIFORNIA, AND DESCRIPTION OF A NEW SPECIES, *T. JOANAE* (DIPTERA: TEPHRITIDAE)

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Abstract.—Thirty-three new rearing records are reported for six of the 12 known species of *Tephritis* known from California, and for the newly described species, *T. joanae* Goeden. Host records remain unknown for two species. The host-plant relations of 11 species for which hosts now have been reported are analyzed and compared for the first time. Six species apparently are monophagous or nearly monophagous, being restricted to a single host genus or known from one or few hosts. Five generalist species that attack hosts in more than one tribe, but are confined to Asteraceae, also are identified and discussed. Some unconfirmed host records for generalist, apparent generalist, and specialist species are questioned.

The host plants of *Tephritis* in California represent four tribes of Asteraceae: Anthemideae, Astereae, Helenieae, and Senecioneae, when questionable host records are discounted. Nine of the 11 species of *Tephritis* in California for which hosts are recorded attack at least one species in the tribe Astereae, the largest of 12 tribes of Asteraceae in California. Five California *Tephritis* may attack only Astereae.

Key Words: Insecta, *Tephritis,* Tephritidae, Asteraceae, flower-head feeders, host-plant specificities, monophagy, gall-formers, resource utilization

Neaspilota, Paroxyna, Tephritis, Trupanea, and *Urophora* (Diptera: Tephritidae) are the most commonly encountered genera among the native, nonfrugivorous, fruit flies of California (Goeden, unpublished data; Foote and Blanc 1963, Freidberg and Mathis 1986). California host-plant records for *Neaspilota, Trupanea,* and *Urophora* were augmented and analyzed by Goeden (1985, 1987, 1989, 1992). Goeden and Blanc (1986) provided new host records for *Paroxyna* from California. This paper reports new rearing records acquired since 1980 and analyzes these and published host records for native California species of *Tephritis.*

Materials and Methods

Materials and methods used were described by Goeden (1985, 1992). Voucher specimens of tephritids reside in my research collection; pressed voucher specimens of uncommon or otherwise poorly represented host-plant species were deposited in the Herbarium of the University of California, Riverside. The holotype, allotype, and six paratypes of each sex of the new species, *Tephritis joanae* Goeden, described herein have been deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. Six additional paratypes of each sex also

reared from *Haplopappus pinifolius* Gray were deposited in the collection of the California Academy of Sciences, and a pair was given to F. L. Blanc for deposit in his collection in thanks for his many past favors.

Results

New rearing records are listed below for seven of 12 species of *Tephritis* known from California (Foote and Blanc 1963, 1979, Foote et al. 1993), including *Tephritis baccharis* (Coquillett), transferred to the genus by Stoltzfus (1977). Host records unreported by Wasbauer (1972), Goeden (1988a), Jenkins and Turner (1989), and Goeden and Headrick (1991a) are listed by genera and species in the manner of Goeden (1992). Unless otherwise noted, all flies were reared from ca. 1-liter samples of mature flower heads. Among multiple samples of a particular newly reported host-plant species, only the sample from which the most individuals of each fly species was recovered is reported. The plant nomenclature used largely follows Munz and Keck (1959) and Munz (1968, 1974). The insect nomenclature follows Foote (1960) and Foote and Blanc (1963, 1979), as amended by Stoltzfus (1977), and McAlpine (1981). Rearing records for the flies and their host plants are listed alphabetically.

Tephritis araneosa (Coquillett)

New host genera: Baccharis, Haplopappus.

New host records: Artemisia californica Lessing; 25 ♂ and 27 ♀; N section, Los Padres Nat. Forest at 610 m, Monterey Co.; 18.iv.1990. *Artemisia douglasiana* Besser; 44 ♂ and 76 ♀; above Perazo Meadow, NW of Truckee at 2000 m, Tahoe Nat. Forest, Sierra Co.; 10.ix.1986. *Artemisia tridentata* Nuttall; 1 ♀; SW of Monitor Pass at 2440 m, Toiyabe Nat. Forest, Alpine Co.; 10.ix.1992. *Baccharis sarothroides* Gray; 1 ♂; Whitewater Canyon, Riverside Co.; 15.x.1987. *Chrysothamnus parryi* (Gray) Greene; 1 ♂ and 8 ♀; SE of Barney Mountain at 1600 m, Lassen Nat. Forest, Shasta Co.; 24.viii.1989. *Chrysothamnus teretifolius* (Durand and Hilgard) Hall; 1 ♂ and 1 ♀; Campito Meadow, Inyo Nat. Forest, Mono Co.; 16.ix.1991. *Chrysothamnus viscidiflorus* (Hooker) Nuttall; 9 ♂ and 2 ♀; Cedar Flat, W of Westgard Pass at 2200 m, Inyo Nat. Forest, Inyo Co.; 29.vii.1986. *Haplopappus bloomeri* Gray; 2 ♂ and 44 ♀; Niagara Creek Campground at 1900 m, Stanislaus Nat. Forest, Tuolemne Co.; 8.vii.1988. *Haplopappus cuneatus* Gray; 16 ♂ and 17 ♀ reared; Lark Canyon, San Diego Co.; 16.x.1980.

Tephritis californica Doane

New host record: Baccharis sarothroides Gray; 3 ♂ and 1 ♀; W of Battle Mountain, S of San Diaguiano River and Lake Hodges at 120 m, San Diego Co.; 27.ix.1990.

Tephritis joanae n. sp.
(description follows)

New host genera: Haplopappus, Senecio.

New host records: Haplopappus ericoides (Lessing) Hooker and Arnott; 10 ♂ and 8 ♀; Orcutt, Santa Barbara Co.; 12.xi.1980. *Haplopappus pinifolius* Gray; 210 ♂ and 196 ♀ reared; Kitchen Creek, Cleveland Nat. Forest, San Diego Co.; 7.x.1981. *Senecio douglassii* (deCandolle); 28 ♂ and 28 ♀; La Posta, San Diego Co.; 15.x.1980.

Tephritis leavittensis Blanc

New host genera: Arnica, Artemisia.

New host records: Arnica amplexicaulis Nuttall; 182 ♂ and 257 ♀; Middle Canyon, E side of White Mountain at 2500 m, Inyo Nat. Forest, Esmeralda Co., Nevada (this location is very close to the California border); 25.vii.1989. *Arnica chamissonis* Lessing; 51 ♂ and 61 ♀; Campito Meadow at 3230 m on White Mountain, Inyo Nat. Forest, Mono Co.; 19.viii.1987. *Arnica longifolia* deCandolle; 5 ♂ and 13 ♀; Deadman Creek, W of Sonora Pass at 2800 m, Tuolemne Co.; 8.ix.1988. *Arnica sororia* Greene; 25 ♂ and 35 ♀; Deadman Creek at 2500 m, Inyo Nat. Forest, Mono Co.; 9.ix.1986. *Ar-*

temisia spinescens D. C. Eaton; ♀; Deep Spring Valley at 1660 m, Inyo Co., 23.iv.1992.

***Tephritis ovatipennis* Foote**

New host genera: Achillea, Artemisia, Hulsea, Machaeranthera, Solidago.

New host records: Achillea millefolium L.; 1 ♂; Fish Creek Meadow, North section, San Bernardino Nat. Forest, San Bernardino Co.; 17.v.1989. *Artemisia ludoviciana* Nuttall; 1 ♂; Lower Deadman Creek Campground, Inyo Nat. Forest, Mono Co.; 21.vii.1987. *Artemisia tridentata* Nuttall; 2 ♀; Horse Meadow Campground, Sequoia Nat. Forest, Tulare Co.; 8.ix.1986. *Erigeron glaucus* Ker; 44 ♂ and 38 ♀; Ocean View Blvd., Pacific Grove, Monterey Co.; 9.iv.1987. *Erigeron lonchophyllus* Hooker; 3 ♂ and 2 ♀; Deadman Creek at 2400 m; Inyo Nat. Forest, Inyo Co.; 21.vii.1987. *Hulsea californica* Torrey and Gray; 171 ♂ and 164 ♀; atop Liebre Mountain, Angeles Nat. Forest, NW Los Angeles Co.; 14.vii.1982. *Hulsea vestita* Gray; 41 ♂ and 60 ♀; Deadman Creek at 2400 m, Inyo Nat. Forest, Inyo Co., 21.vii.1987. *Machaeranthera canescens* (Pursh) Gray; 2 ♂ and 1 ♀; above Mahogany Creek at 2300 m, Sequoia Nat. Forest (N section), Tulare Co.; 7.vii.1984. *Solidago canadensis* L.; 9 ♂ and 9 ♀; Dead Man Creek at 2500 m, Inyo Nat. Forest, Mono Co.; 9.ix.1986. *Solidago confinis* Gray; 4 ♂; Antelope Spring, Deep Spring Valley, Inyo Co.; 15.ix.1982.

***Tephritis signatipennis* Foote**

New host genus: Aster.

New host record: Aster integrifolius Nuttall; 8 ♀; E of Ebbetts Pass at 2360 m, Toiyabe Nat. Forest, Alpine Co.; 30.vii.1992.

***Tephritis stigmatica* (Coquillett)**

New host genus: Haplopappus.

New host records: Haplopappus propinquus Blake; 1 ♀; Mountain Springs Pass, SE San Diego Co.; 7.x.1987. *Haplopappus venetus* (von Humboldt) Blake; 1 ♂; Cardiff-by-the-Sea, San Diego Co.; 15.x.1980. *Senecio clarkianus* Gray; 3 ♂; Poison Meadows, 16 km from Bass Lake at 2000 m, Sierra Nat. Forest, Madera Co.; 16.viii.1988. *Senecio scorzonella* Greene; 2 ♀; Kaiser Pass at 2700 m, Sierra Nat. Forest, Fresno Co.; 17.viii.1988. *Senecio serra* Hooker; 6 ♂ and 7 ♀; S of Sawmill Flat, above N Fork Kings River at 2300 m, Sierra Nat. Forest, Fresno Co.; 22.vi.1989.

Discussion

Since 1980, I have reared nine of the 13 species of *Tephritis* currently reported from California (Foote and Blanc 1963, 1979, Foote et al. 1993) or newly described herein. Among the nine species from California reared by me or others (Wasbauer 1972), only *T. baccharis* is known to be a strictly monophagous, obligate gall former (Jenkins and Turner 1989, Goeden and Headrick 1991a). A single male specimen of *T. webbii* Doane was reared from a gall in the flower head of "goldenrod," *Solidago* sp. (Quisenberry 1951, Wasbauer 1972), but this is all that is known about the biology and host relationships of this species. *Tephritis stigmatica* also forms galls on branches and stems of *Senecio douglassii* (Goeden 1988a), and additionally infests the flower heads of this host, which are not galled (Foote and Blanc 1963, Tauber and Toshi 1965, Wasbauer 1972); otherwise, it presumably only has been reared from ungalled flower heads of several alternate host species (Foote and Blanc 1963, Tauber and Toshi 1965, Wasbauer 1972, and the present paper).

Tephritis arizonaensis Quisenberry was reported as reared variously from "terminal galls," "stem tip mines," and "female flowers" of *Baccharis sarothroides* Gray by Jenkins and Turner (1989); whereas, Goeden et al. (1993) found no galling, only branch-tip mining for spring (F_1) generations, and female *and* male flower head-feeding for fall (F_2) generations of this tephritid on this same host in southern California.

The "unpublished" host record for *T. sig-*

natipennis Foote from *Machaeranthera canescens* in Wasbauer (1972) has not been confirmed. As reported above, I have reared only *T. ovatipennis* from *M. canescens.* My recent rearing record from *Aster integrifolius* reported above was confirmed by rearing 2 ♀ from another sample of heads from the same host collected W of Sonora Pass at 2580 m, Toiyabe Nat. Forest, Alpine Co., again on 29.vii.1992.

The remaining four species of *Tephritis* for which host plants are known, i.e. *T. araneosa, T. californica, T. candipennis,* and *T. ovatipennis,* presumably only have been reared from flower heads; although, most details of their life histories, including whether gall formation also is involved, are unknown (Foote and Blanc 1963, 1979, Wasbauer 1972, Jenkins and Turner 1989). The life histories of several of these species currently are under study by me and my associates. Host plants still are unknown for the two remaining species of *Tephritis* reported from California: *T. labecula* Foote and *T. rufipennis* Doane (Wasbauer 1972, Foote et al. 1993).

The host specificities of the following florivorous species are assessed as oligophagous, i.e. attacking more than one genus in a single tribe, or as generalists, i.e. attacking different genera belonging to more than one tribe of Asteraceae (Goeden 1985, 1992):

Tephritis araneosa is an apparent generalist now known from eight genera and 14 species of hosts in the tribes Anthemideae, Astereae, and Senecioneae (Foote and Blanc 1963, 1979, Wasbauer 1972, and the present study). However, this interpretation discounts the host record for *Poa* sp. in the Graminae (Wasbauer 1972), from which no Tephritidae are otherwise known (Freidberg and Kugler 1989), as highly unlikely and probably erroneous. I have confirmed the host records in Wasbauer (1972) for *Artemisia dracunculus* L. and *Chrysothamnus nauseosus* (Pallas) Britton, but as yet have not confirmed records from *Arnica chamissonis* Lessing, *Erigeron pumilus* Nuttall, or *Grindelia* sp. The record for *A. chamissonis* in Wasbauer (1972) probably applies instead to *T. laevittensis,* shown in the present study to be closely associated with the genus *Arnica,* and described in Foote and Blanc (1979) as a member of a complex containing *araneosa,* which as discussed below, some specimens of *laevittensis* closely resemble. Similarly, the published rearing record for *E. pumilus* may rightly apply to *T. ovatipennis,* known now from three other species of *Erigeron*; the latter species also belongs to the "*araneosa* complex" recognized by Foote (1960) and Foote and Blanc (1979).

In preparing the present report, I ascertained that the aforementioned complex contains at least one additional, undescribed species, which I now describe using the format of Foote and Blanc (1979), the methods of measurement of Jenkins and Turner (1989), and the terminology in McAlpine (1981) for 12 specimens of each sex. The new species runs to *signatipennis* Foote (couplet 10) in the key to North American species of *Tephritis* in Foote et al. (1993). The following key to replace couplet 10 enables one to distinguish these closely related species (parenthesized additions and deletions mine):

10. Cell a_2 with dark markings extended at least halfway from vein A_2 to wing margin, often touching the margin 10a
– Cell a_2 entirely hyaline or at most narrowly dark along vein A_2 11
11. Wing (Fig. 1) with hyaline spot in basal end of cell r_{4+5} large, oval to quadrate, and extended from vein R_{4+5} to vein M (often broadly based on latter), usually contiguous with hyaline area in cell r_{2+3} directly anterior to it ..... *joanae* Goeden, n. sp.
– Wing with hyaline spot in basal end of cell r_{4+5} smaller, round or oval, and not extended to vein R_{4+5}, but sometimes touching vein M ..... *signatipennis* Foote

Tephritis joanae Goeden, New Species

Head.—In profile, 1.1–1.4 times as high as long, face distinctly protruding below an-

Fig. 1. Right wing of *Tephritis joanae*, female.

tennae, face and frons meeting at an angle of about 135°; gena below eye 0.14–0.18 times eye height, genal bristle and genal setulae white to dark brown; occiput swollen; frons dark yellow, about 0.6 mm wide at vertex, narrowing to about 0.5 mm at antennal bases, 0.4–0.5 mm long; the 2 frontal setae shining dark brown; posterior orbital seta white, 0.5–0.8 times as long as anterior; verticals ⅔–¾ as long as head height; face, including antennal foveae, dark yellow; palpi yellow, with 5–10 prominent black setulae apically; antenna 0.6–0.8 as long as face, arista dark brown except base dark yellow.

Thorax.—Scutum, scutellum, and pleural sclerites brownish gray pollinose, with 3 brown dorsolongitudinal stripes, 1 medial, and 2 more lateral and in line with dorsocentral bristles; scutellum darker centrally than marginally; complement of thoracic bristles usual for the genus, all black except posterior notopleural, white; subscutellum and mediotergite black and gray rather than brownish gray pollinose; scutal setulae white, inserted closer to each other than their average length; scutellum bare centrally, setulae present only laterally; halteres whitish. Legs entirely yellow; hind tibia of both male and female with parallel rows of black setulae and distinct anterodorsal row of dark brown to black setae on basal ⅔, the longest seta about as long as width of tibia; hind femur with black setulae on posterior fourth. Wing pattern as in Fig. 1, with a prominent hyaline area immediately distad of pterostigma extended from costal margin posterior to and touching vein M, thus, hyaline spot in basal end of cell r_{4+5} is oval to quadrate; dark area in pterostigma extended posteriorly without hyaline spots to vein R_{2+3}, thence to vein R_{4+5} with a few hyaline markings, and continued on to posterior margin with prominent hyaline spots of increasing size; cross vein r-m removed from crossvein dm-cu by about its own length; triangular extension of basal cubital cell almost equilateral; cell a_2 light brown to posterior margin between larger hyaline spots.

Abdomen.—All tergites dark gray pollinose except T_1, which has black spot medially, but otherwise is concolorous with brownish scutum and scutellum, rather than blackish mediotergite, other tergites without pattern; densely covered with colorless setulae inserted much closer to each other than their average length, becoming longer laterally and posteriorly; 4 long, brown or black setae laterally along posterior margin and 2 setae laterally on last abdominal tergite; oviscape flat, dark reddish brown to black, with setulae on basal ⅔ similar to

those on abdominal tergites, apically with extremely fine short black hairs; in dorsal view about 2 times as long as last abdominal tergite and 0.9–1.3 as wide at base as long.

Holotype, female, Lake Morena, San Diego Co., Calif., 18.x.1980, reared from flower head of *Haplopappus pinifolius,* R. D. Goeden. Allotype, same data as holotype (USNM). Paratypes: CALIFORNIA: 29 females and 26 males, same data as holotype. Also reared from *H. pinifolius*: 12 ♂, 12 ♀; McCain Valley, San Diego Co.; 16.x.1980. 12 ♂, 12 ♀; Lark Canyon, San Diego Co.; 29.x.1980. 7 ♂, 8 ♀; Campo, San Diego Co.; 29.x.1980. 6 ♂, 6 ♀ mounted (paratypes) of 144 ♂, 133 ♀ reared (remainder discarded, as also noted below); N of Thomas Mountain, San Bernardino Nat. Forest (S section), Riverside Co.; 29.ix.1982, 6 ♂, 6 ♀ mounted of 210 ♂, 196 ♀ reared; Kitchen Creek, Cleveland Nat. Forest, San Diego Co.; 7.x.1981. 6 ♂, 8 ♀ mounted of 108 ♂, 111 ♀ reared; W of Boulevard at 1020 m, San Diego Co.; 6.xi.1986. 5 ♂, 7 ♀ mounted of 8 ♂, 8 ♀ reared; Cameron Corners at 910 m; San Diego Co.; 6.xi.1986. 6 ♂, 6 ♀ mounted of 157 ♂, 184 ♀ reared; Live Oak Springs on Tecate Divide at 1220 m, San Diego Co.; 8.x.1987. 6 ♂, 6 ♀ mounted of 7 ♂, 11 ♀ reared; Smith Canyon E of Campo at 990 m, San Diego Co.; 20.x.1987. Additional specimens identified, but not designated as paratypes, include those reared from: *H. ericoides*; 10 ♂, 8 ♀; Orcutt, Santa Barbara Co.; 12.xi.1980. 2 ♂, 1 ♀; Orcutt; 7.xii.1982. *Senecio douglassii*; 12 ♂, 12 ♀ mounted of 28 ♂, 28 ♀ reared; La Posta, San Diego Co.; 15.x.1980.

Etymology: Tephritis joanae is named for my wife, Joan, who for many years has tolerated with understanding my entomological activities and helped me to surmount the less understandable, human aspects of my profession.

Tephritis joanae belongs to the "*araneosa* complex" comprising *araneosa, candidipennis, leavittensis, ovatipennis,* and *signatipennis* (Foote 1960, Foote and Blanc 1979). All were available to me for comparative study as series of reared specimens from southern California, the type locality of *araneosa* (Coquillett 1894). As discussed by Foote and Blanc (1979), the principal differences among most species in this complex are the degree of infuscation of the wing patterns and attendant sizes of the hyaline areas. However, the dark band from the pterostigma to vein R_{4+5} is situated at right angles to the horizontal axis of the wing in most *candidipennis* and *leavittensis* (see comments below); whereas, this band extends obliquely to cover crossvein r-m in the other species, including *joanae.* Among the obliquely banded species, however, only *joanae* and *signatipennis* have anal cells darkened to or nearly to the posterior margin, but with large hyaline spots. These two species are distinguished readily by the size and shape of the hyaline spot in cell r_{4+5}, which in the former species is much larger and subquadrate as in *araneosa,* touching both veins R_{4+5} and M. Furthermore, *araneosa,* which was described by Coquillett (1894) from four females from southern California, has an oviscape about equal in length to the terminal abdominal tergite; whereas, in *joanae* the oviscape length is about twice the length of this tergite. Moreover, *araneosa* adults are shorter on average than *joanae.* Twelve each, males and females of *araneosa* from *Artemisia californica* averaged 2.5 ± 0.06 (range, 2.0–2.7) mm and 2.9 ± 0.06 (range, 2.7–3.3) mm in length, respectively, about 1 mm shorter than 12 males and 12 females of *joanae,* i.e. 3.5± 0.07 (range, 3.2–3.9) mm and 4.0 ± 0.04 (range, 3.7–4.2) mm, respectively, from *H. pinifolius.*

Thus, *araneosa,* as a presumed mixture of species has yielded still another new species (Foote and Blanc 1979), and probably contains at least one more unnamed species with an intermediate ratio of oviscape to last abdominal tergite of ca. 1.5, that if or

when described by me elsewhere after additional study, may reduce the host range of *araneosa* to that of a nearly monophagous species associated with *Artemisia* spp. The life histories and immature stages of *T. araneosa, T. joanae,* and this apparent, but still undescribed species from *Chrysothamnus* and *Haplopappus* are under study by me and my associates and will be reported on separately in the future.

Tephritis californica now is reported from three species of *Baccharis* in the tribe Astereae and an unidentified species of *Senecio* in the tribe Senecioneae (Wasbauer 1972, Jenkins and Turner 1989, and the present study). I have reared this questionably generalist tephritid from the flower heads of *B. pilularis,* and as both male and female flies from large samples of male and female flower heads of *B. sarothroides.* The latter samples were taken from areas where these two, closely related, otherwise largely allopatric hosts, were sympatric; therefore, this record may have resulted from ovipositional "spillover" as is thought to occur in other tephritid genera (Goeden 1985, 1988b, Goeden, Headrick, and Teerink, unpublished data). Like Jenkins and Turner (1989), I have been unable to confirm the "unpublished" record in Wasbauer (1972) for *B. emoryi* Gray from two, large samples of mature flower heads that failed to yield any tephritid. Similarly, the "unpublished" record for *Senecio* sp. in Wasbauer (1972) remains unconfirmed, and is somewhat suspect, as only *T. joanae* and *T. stigmatica* have been reared by me from flower heads and galls on plants in this genus to date. Thus, in reality, *T. californica* probably is nearly monophagous on *B. pilularis.* The light morphs, i.e. F_1 flies, apparently emerge from still-undetected, galls or branch-tip mines on nonflowering, vegetative branches in the spring; whereas, the dark morphs, i.e. F_2 flies, emerge from flower heads in the fall (Jenkins and Turner 1989). This life history scenario is similar to that of *T. arizonaensis* on *B. sarothroides* in southern California (Goeden et al. 1993) and *T. palmeri* Jenkins on *B. neglecta* Britton and *B. halimifolia* L. in Texas (Jenkins and Turner 1989).

Tephritis candidipennis may be another species currently considered a generalist, that actually is a monophage. It is reported from two species of *Tanacetum* in the tribe Anthemideae, and one species each in the genera *Ambrosia* (tribe Heliantheae) and *Arnica* (tribe Senecioneae) (Wasbauer 1972). The "unpublished" record from *Ambrosia chamissonis* (Lessing) Greene in Oregon is questionable, based partly on my studies of the insect fauna of this native ragweed (Goeden and Ricker 1974). Other than this suspect record in Wasbauer (1972), no *Tephritis* is known from *Ambrosia,* from any other genus in the subtribe Ambrosiinae in North America (Goeden and Teerink in press, Goeden and Palmer in press), or from any other Heliantheae (Wasbauer 1972, and the present study). Again, I have never reared *T. candidipennis,* only *T. leavittensis* from *Arnica* spp., including *Arnica chamissonis* in the present study. Indeed, *T. candidipennis* may be nearly monophagous on *Tanacetum* spp. from which rearing records appear less ambiguous (Quisenberry 1951, Foote and Blanc 1963, Wasbauer 1972).

Tephritis leavittensis has been reared in California from flower heads of four species of *Arnica* in the tribe Senecioneae and *Artemisia spinescens* in the Anthemideae. These are the only rearing records known for this species described in part from specimens swept from *Arnica longifolia,* which thus provided an example of a sweep record indicative of a reproductive host-plant relationship, despite repeated admonitions to the contrary by me elsewhere (e.g. Goeden and Ricker 1986, Goeden 1988a, Headrick and Goeden 1991; but also see Goeden and Headrick 1991b).

Some of the *T. leavittensis* reared from *Arnica* spp., including parts of those series reported in the present study, had wings on

which the "dark band covering the subcostal cell extended obliquely to cover vein r-m," i.e. it was not ". . . situated at right angles to the horizontal axis of the wing," the opposite of the key character described in Foote and Blanc (1979). Thus, the key character used to separate *leavittensis,* along with *candidipennis,* was invalid in 30 of the 129 (23%) mounted specimens reared from capitula of *Arnica* spp. housed in my collection during the present study. This ratio varied from one of six (17%) specimens mounted and reared from *A. sororia* collected 24.vii.1984, to nine of 32 (28%) specimens mounted of those reared from *A. sororia* collected 9.ix.1986, to seven of 22 (32%) specimens mounted of those reared from *A. chamissonis* collected 19.viii.1987, to two of 11 (18%) specimens mounted and reared from *A. longifolia* collected 8.ix.1988, to 10 of 38 (26%) specimens mounted and reared from *A. amplexicaulis* collected 25.vii.1989, to one of five (20%) specimens mounted and reared from *A. chamissonis* collected 17.ix.1991. These specimens keyed to *T. araneosa,* and provide another possible explanation for continuing records of *T. araneosa* from *Arnica* spp.

Tephritis ovatipennis is a generalist now known from seven genera and 12 species of host plants in three tribes, i.e. Anthemideae, Astereae, and Helenieae (Wasbauer 1972, and the present study). Included among these hosts are two species of *Artemisia,* a genus which, as noted above, also is attacked by *T. araneosa.* The sharing of host-plant genera and even individual host species by congeneric generalists was documented among species of *Trupanea* by Goeden (1992). *Tephritis ovatipennis* is the only Nearctic species in this genus reported from Helenieae. The record for *Corethrogyne filaginifolia* in Wasbauer (1972) has not been confirmed; however, another record for *Erigeron foliosus* (Wasbauer 1972) was confirmed, and augmented by rearing records for two other *Erigeron* spp. in the present paper.

Tephritis stigmatica is another generalist now known from five genera and 12 species in two tribes, Astereae and Senecioneae (Wasbauer 1972, and the present study). I have not confirmed the records for *Arnica chamissonis* and *Chrysopsis* (as *Heterotheca*) *breweri* in Wasbauer (1972), nor the record for *Aster canescens* (Pursh) Gray in Novak et al. (1967). The principal host genus of this fly appears to be *Senecio.* Six species of which are reported as hosts. On at least one of these, *T. stigmatica* forms branch and stem galls besides attacking flower heads, as noted above (Goeden 1988a). *Tephritis stigmatica* also shares the large and diverse host genus *Haplopappus* with *T. araneosa* and *T. joanae,* although different host-plant species are attacked by each of these species. The records for *T. stigmatica* also represent single specimens reared only once from each species of *Haplopappus,* and, therefore, could also have resulted from "spill-over" errors in oviposition mentioned above with *T. californica.*

Thus, the known host plants of *Tephritis* in California represent four tribes of Asteraceae: Anthemideae, Astereae, Helenieae, Senecioneae (discounting the questionable records noted above). Nine of 11 species of *Tephritis* from California for which host plants have been reported, i.e. all except *candidipennis* and *leavittensis,* attack at least one species in the tribe Astereae; five species apparently attack only Astereae, again discounting the questionable host record from *Senecio* for *T. californica.* Three of the four subtribes of Astereae in California are represented among hosts of *Tephritis.* The fourth subtribe, Bellidinae, contains only the naturalized English daisy, *Bellis perennis* L. The Astereae also is the largest of 12 tribes of Asteraceae in California, with the Helenieae and Senecioneae as the third and fifth largest (Munz and Keck 1959, Goeden 1992).

Tephritis thus shows a broader host range among tribes of California Asteraceae than *Neaspilota* and *Urophora.* The host plants of *Neaspilota* in California are mainly in the

Astereae, with at least one confirmed host plant in the tribe Cichoreae (Goeden 1989). The hosts of native *Urophora* in California are concentrated in the subtribe Solidagininae of the Astereae (Goeden 1987). The host plants of *Trupanea,* on the other hand, represent nine of the 12 tribes of Asteraceae found in California (Goeden 1985, 1992); whereas, the host plants of *Paroxyna* represent seven tribes of California Asteraceae (Wasbauer 1972, Novak 1974, Goeden and Blanc 1986, Goeden, unpublished data).

Knowing these host plant affinities may help to locate hosts of unreared *Tephritis* and unreared species in other genera occurring in California. Locating a good field population of an unstudied species of tephritid is the prime requisite for productive investigation of its life history and descriptions of its immature stages, as our recent efforts in California demonstrate.

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